Sixty-eight presents were announced as having been received since the last meeting, including amongst others :—

Ph. Fauth, Beobachtungen der Planeten Jupiter und Mars, 1896–97, III. ; J. N. Krieger, Mond-Atlas, Band I. ; A. Stanley Williams, Catalogue of the magnitudes of 1081 southern stars, presented by the authors ; Paris Observatory, Atlas photographique de la lune, par MM. Lœwy et Puiseux, fasc. 2 ; Potsdam Observatory, Publicationen, Band XI. ; presented by the Observatories ; Set of transparencies from negatives of the total solar eclipse of 1898 January 22, presented by the Astronomer Royal ; Photographs of the total solar eclipse of 1898 January 22, presented by C. Thwaites.

The Spectrum of o Ceti as photographed at Stonyhurst College Observatory. By the Rev. Walter Sidgreaves, S.J.

The series of photographs of the spectrum of *o Ceti*, obtained during the recent favourable period of its maximum light, consists of 20 plates, on 15 nights, beginning with 1897 November 18, and ending on 1898 February 5. Six of these were taken in November on the dates 18, 23, 24, 28, 29 ; twelve in December on dates 1, 2, 11, 15, 19, 24, 25, 28, 30 ; one on January 7, and one on February 5.

All the photographs are upon Edwards' Isochromatic plates, excepting the one of December 30, which is on a Mawson plate. All are good photographs ; but the accompanying tables of wave-lengths (p. 348), and the map of the spectrum (plate 3),* are formed upon one plate, that of November 29, supplemented, in the violet, by the Mawson plate of December 30. These were judged to be the best of the series. Eleven other plates were selected for measures of the sharp edges of the bands, to serve as a check upon the scale readings used for the map and tables.

The map has been executed with the greatest care, to represent as closely as possible the relative radiation-energy of each part of the spectrum as it arrives upon the plate, allowance being made everywhere for the sensibility curve of Edwards' Isochromatic plate ; and this curve has been estimated upon the supposition of uniform energy at all the parts of the spectrum of *α Tauri*.

The spectrum has apparently remained substantially constant during the period of observation. But a marked change in the relative intensities of the yellow-green and the blue radiations

* Two photographic mounts presented to the Society with this Paper are reproduced as Plate 1 and Plate 2. They are direct enlargements from the original negatives, widened by a cylindrical lens. All the lines have been verified by comparison with enlargements made without the cylindrical lens. They do not show all the details of the original negatives.

appears to have taken place during the cloudy week between December 2 and December 11. On all the preceding dates the photographs show the maximum silver deposit in the blue region of the spectrum; and on all the subsequent dates the yellow-green radiation has produced a stronger impression. This alteration is illustrated by three enlargements on Plate 1.

Of the hydrogen lines H_ϵ is still absent, lost, or much weakened in the calcium absorption; and H_β may be visible as a division of the band which begins at λ 4842. This division of the band is at 4861, the position of H_β, and is, on this account only, entered in Table I. as a bright line, but without an estimated intensity, the brightness being less than that of the continuous spectrum. But it is not easy to reconcile the comparatively weak absorption at this part of the band in *Mira* with its supposed absorbing action on the very energetic radiation of H_β. The hydrogen tubes in the laboratory give H_β very greatly over-exposed, when the time has been long enough to give H_δ the precise character of the line on the star plates. And we have to take into consideration the extraordinary brilliancy of the two lines H_δ and H_γ in the star's spectrum: it is too great to be shown on a drawing, or to be safely expressed by a number representing relative intensity. These lines are so strong on the negatives that it is not easy to darken them on a positive enlargement by over-exposure; and they remain perfectly clear, when the over-exposure has been long enough to darken greatly all the other bright zones of the spectrum. It seems more probable that *o Ceti* shows a condition of hydrogen radiance not yet met with in the laboratory, in which H_α and H_β have fallen out of the spectrum.

Professor Keeler's remark on the spectrum of *a Herculis* is applicable to the spectrum of *o Ceti*. He says,* "It is impossible to avoid the conclusion that the edges of the zones bordering on the dark bands are bright—much brighter, that is, than the average continuous spectrum." These zones are given in Table I. according to our estimate of the relative intensities representing continuous spectrum.

The band having its sharp edge at λ 5162 has been the subject of careful examination. The question at the beginning was whether we had to deal with a bright fluting shading towards the violet or not. Our judgment of the brightness of this region, referred to the continuous spectrum as zero, is given in Table I. in favour of a possible bright band. But there is an absorption band shading from the same position, 5162, in the opposite direction. Of this there can be but little doubt; it is impossible, without it, to interpret the photographs consistently with the sensibility curve of the isochromatic plate, unless we suppose the green radiation to be less energetic in this class of stars than in stars nearer to the solar type. The two bands, one bright and

* *Astronomical Journal*, vi. 5, p. 424.

fading towards the blue, the other dark and shading towards the red, cannot well stand together with a common termination ; and there is no appearance of overlapping, which ought to manifest itself as a pale separating band. For this reason our photographs seem to be against the carbon origin of the brightness at λ 5162.

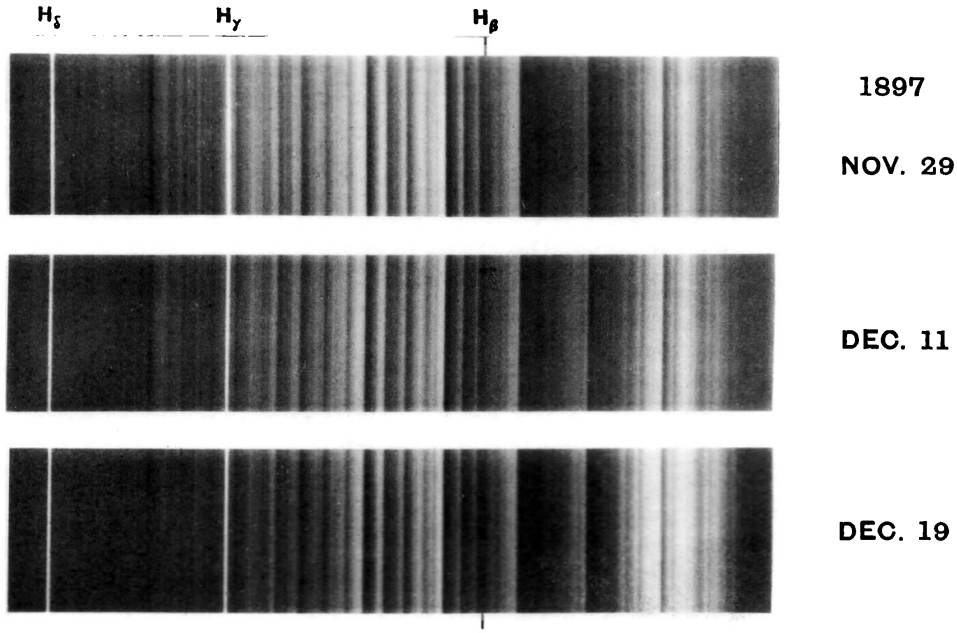
In Plate 2 the position of *o Ceti* in Secchi's third type, in gradations towards the second type, is shown by comparison with the spectra of other stars, in the order *α Herculis*, *β Pegasi*, *η Geminorum*, *α Orionis*, *β Andromedæ*, and *α Tauri*. It is more remote from the solar spectrum than *α Herculis*. Its bands or flutings are stronger, as noted by Lockyer in 1893, but the chief differences between the two spectra, omitting the hydrogen lines, are the more decided fluting character of the bands of *o Ceti* on the violet side of λ 471, and the remarkably strong radiation of *α Herculis* between λλ 4227 and 4458.

The line spectrum of *o Ceti* places the star in Lockyer's subdivision *a* of Table C. He finds, besides hydrogen, iron, manganese, calcium, chromium, cobalt, titanium, and strontium, common to them all,* and the calcium lines intensified, as compared with those in the solar type of spectra. The strong absorption line† in the photographs of Plate 1, between H_δ and H_γ is at λ 4227, and is therefore probably the strong calcium line at 4227. Another strong line on the more refrangible side of H_δ, very distinct on the negatives, is at λ 4077, the position of one of the strongest strontium lines. Other lines are equally precise coincidences with known strong lines in the arc spectra of strontium and iron. In Table II. of wave-lengths a comparison column is added for the spectra of iron, and other metals in which all and only those lines are entered which have the note of full intensity in Watts' Index of Spectra, within the limits of the photograph. The brackets in the column of band numbers show the widths of the bands, and enclose the superimposed lines. A band terminates with a spectral line when the terminating wave-length is not enclosed in a round bracket. The round bracket signifies the termination only, and not a line. A square bracket covering a number of wave-lengths within a band signifies that these would not be seen as separate lines without careful examination of the original plates.

The grouping of the bands is not marked in the table of wave-lengths. But it is very apparent on the photographs : they run in quartets, with deepest absorption on the violet sides, and general shading towards the red sides. These appear as single bands in the smaller spectrum given by a half prism and short focus camera.

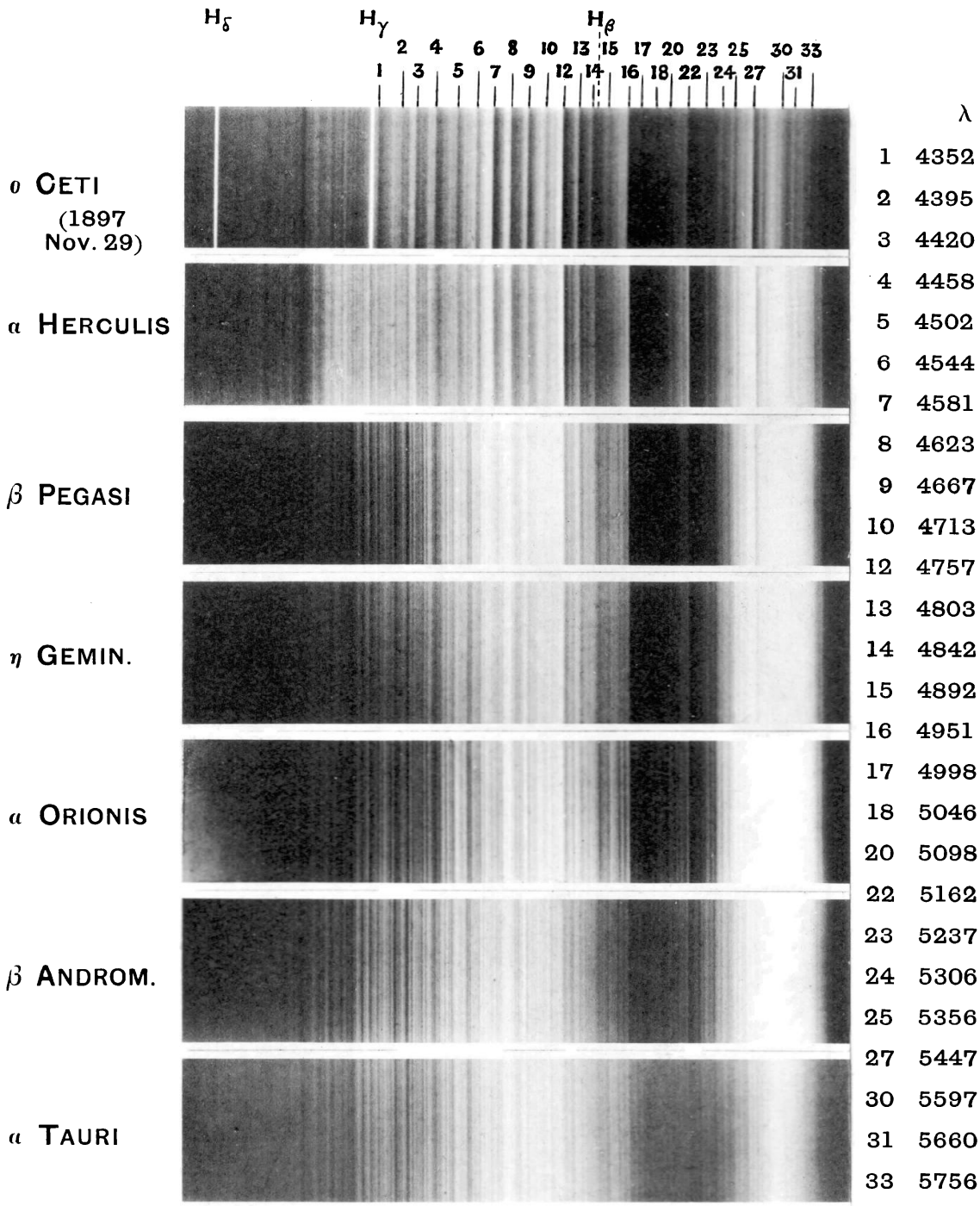
* *Phil. Trans.* vol. clxxxiv. p. 705.

† This line appears on all the photographs of Plate 2, but not with its proper strength, this end of the spectrum having been sacrificed in the original negatives in order to bring out the lines in the more sensitive part of the plate. It shows as the strongest absorption line in the spectrum of *α Tauri* on plates of long exposure.



SPECTRUM OF o CETI, SHOWING A PROGRESSIVE CHANGE IN THE RELATIVE RADIATIONS OF THE BLUE AND YELLOW REGIONS, STONYHURST COLLEGE OBSERVATORY

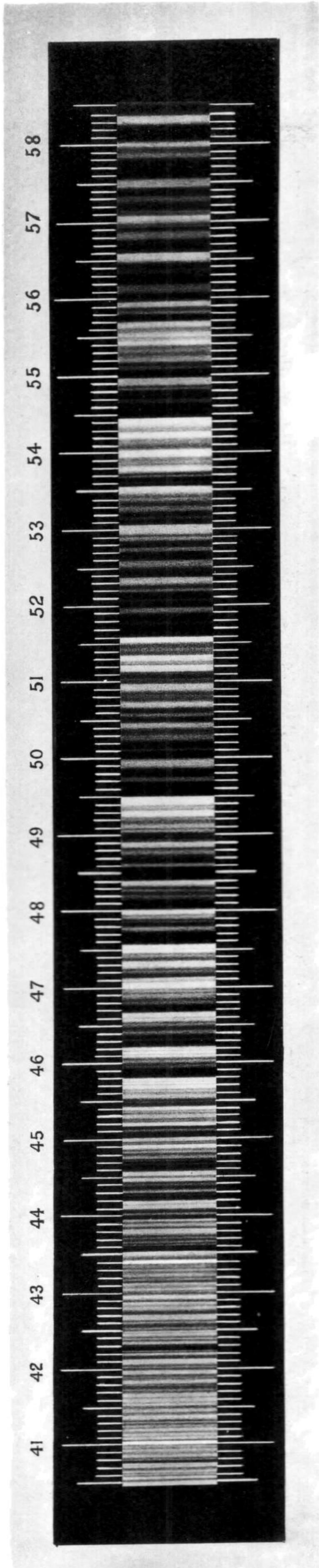
Spottiswoode & Co. London



PROGRESSIVE STELLAR SPECTRA BETWEEN SECCHI'S 3RD AND 2ND TYPES

STONYHURST COLLEGE OBSERVATORY

Spottiswoode & Co. London.



SPECTRUM OF o CETI, DRAWN FROM A PHOTOGRAPH TAKEN ON NOVEMBER 29, 1897,
AT
STONYHURST COLLEGE OBSERVATORY

Spottiswoode & Co. London.

A close examination of the enlarged photographs of Plate 2 shows a marked difference either in the real positions of the sharp edges of the bands, or in the lengths of the photographed spectra. In the latter supposition o *Ceti* shows a shorter spectrum, and α *Herculis* a longer one than β *Pegasi* or α *Orionis*. These differences are not owing to inexactness of enlargement. They were shown on the original plates, by the micrometer, before the enlargements were made. It is impossible to escape the conclusion that they are owing to some instrumental defect; but so far the cause is not clear. Something may be set down—1st, to the relatively great flexure of the telescope tube, owing to the form of mounting necessary for the adaptation of the large object glass; 2nd, to imperfect centering of the light rays through the prism; 3rd, to micrometer imperfections; and, 4th, to differences of temperature. But the maximum effects of these have been measured, and found to be insufficient, when taken together, to account for the differences. There remains only the photographic effect of longer exposure, corresponding to the widening of a bright line. This would be to increase the length between the fiducial position, H_γ, and the edges of the bands in the green-yellow regions; but that no appreciable effect of this nature can be admitted in the photographs is shown by two exposures on the night of November 23. One of these was by a slow trail corresponding to a long exposure, and the other by a very quick trail. The latter gave a weak photograph with excellent definition, to compare with the strong photograph of the longer exposure; and both exposures were upon the star at the same average altitude, east and west of the meridian. The positions of the bands by both plates were the same.

With these considerations before us we are forced to admit the probability of a real difference between the positions of the strong edges of the bands in o *Ceti* and in α *Herculis*, as compared with the remaining stars of Plate 2. These differences appear in the following table of positions of the edge of Duner's band 5 (No. 27 of our photographs on Plate 2).

	Edge of Band.
o Ceti	5447
β Pegasi	5451
α Orionis	5451
α Herculis	5458

TABLE I.

Bright Lines, and possible Bright Bands, in the spectrum of o Ceti.

	Wave-length.	Intensity.	Remarks.
H_δ	4101	10	Sharp line.
H_γ	4340	10	,, ,,
1	4566–4580	1	
2	4608–4622	1	
3	4700–4756	2	
	4861		Presumably H_β: a faint narrow division in a broad absorption band.
4	4924–4950	2	
5	5114–5161	2	
6	5374–5446	2	

TABLE II.

Absorption Spectrum of o Ceti.

Band Nos.	o Ceti. Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.	Band Nos.	o Ceti. Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	4052	2			4116	1	
	4059	1 *f*			4123	1 *f*	
	4063	1 *f*	4063 Fe		4128	2	
	4068	2	4071 Fe		4133	2	4131 Fe
	4077	4	4077 Sr		4142	2	4143 Fe
	4082	1			4151	2	
	4088	1			4156	1 *f*	
	4095	1 *f*			4164	1 *f*	4163 Ti
	4098	1 *f*			4169	2	4171 Ti
	*4105	2			4176	3	
	4112	1 *f*			4180	2 *f*	

w = wide line
f = narrow or fine
b = band.

* See bright line spectrum (Table I.)

o Ceti.

Band Nos.	Wave-lengths.	Intensity and aracter.	Strong lines of Iron, &c.
	4187	2	4187 Fe
	4192	2	4191 Fe
	4199	2	4199 Fe
	4205	2	4202 Fe
	4215	4	4215 Sr
	4222	4 *f*	4227 Ca, Mn
	4227	10 *w*	
	4231	4 *f*	
	4236	2	4235 Mn
	4242	2	
	4247	1 *f*	
	4251	2 *f*	4250 Fe 4254 Cr
	4256	3	
	4262	2	4260 Fe
	4273	3 *w*	4271 Fe 4272 Mn 4275 Cr
	4282	1	4281 Thorium
	4290	2	4289 Cr
	4299	2	4299 Fe Ti
	4302	1 *f*	4302 Ca 4305 Sr
	4308	1	4307 Fe
	4315	2	4315 Fe
	4320	1	
	4326	1	4325 Fe Mn
	4333	1	
	4337	1	4337 Fe 4338 Ti
	*4345	2	
1	(4352)	7	4358 Hg
	4354	7	
	4359	6	
	4363	2 *f*	
	4369	3	
	4373	3	
	(4375)	2	4379 Vanadium 4382 Thorium

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	4385	3	4383 Fe 4384 Vanadium
	4392	2	4393 Ti Tho
2	(4395)	5	
	4397	5 *w*	
	4407	5 *w*	4405 Fe 4408 Vanadium
	(4409)	5	
	4415	1 *f*	4415 Fe Mn
3	(4420)	4	
	4421	4 *f*	
	4424	6 *w*	4425 Ca
	4429	4	4427 Ti
	4435	5 *w*	4435 Ca 4442 Fe 4443 Ti
	4442	4	4436 Mn
	4450	2	4447 Fe 4451 Mn
4	(4458)	6	4454 Ca 4455 Mn
	4459	6 *f*	4457 Mn 4461 Mn
	4463	7 *w*	4464 Mn
	4470	6	4469 Ti 4470 Mn
	4474	5	4472 Mn 4475 Fe
	4480	3	4482 Fe
	4486	2	
	4494	2 *f*	4489 Mn 4494 Fe
	4496	2 *f*	4498 Mn
5	(4502)	6	4501 Ti Mn
	4504	6	
	4506	6	
	4514	5	
	(4517)	5	
	4523	2 *f*	4524 Sn 4526 Ti 4528 Fe
	4526	2 *f*	
	4533	2 *f*	

w = wide line. *f* = narrow or fine. *b* = band.

* See bright line spectrum (Table I.)

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	4537	1 *f*	4536 Ti
6	(4544)	5	
	4546	5 *w*	4549 Ti
	4551	5	
	4560	2	
	4565	1	
	4571	1 *f*	4572 Ti
	4575	1 *f*	
7	(4581)*	10	
	4583	10 *w*	
	4589	10 *w*	
	4599	4	4602 Fe
	4605	4	
	(4607)	4	4607 Sr
	4613	1 *f*	
	4617	1 *f*	
* 8	(4623)	8	
	4626	8 *b*	
	4635	7 *w*	
	4646	5 *w*	4639 Ti
	4653	3	4654 Fe 4656 Ti
	4660	1 *f*	
9	(4667)	9	4666 Fe
	4670	9 *w*	
	4675	8	4678 Fe 4679 Zn
	4683	3	
	4692	2	4691 Fe
	4697	2	
	(4699)	2	
	4708	1 *f*	4707 Fe 4709 Mn
10	(4713)	4	
	4715	4 *w*	
	4723	3	4721 Zn
	(4725)	3	4726 Mn

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
11	(4735)	3	
	4738	3	4736 Fe
	4744	2	
	4750	1 *f*	4753 Mn
12	(4757)*	10	4757 Ti
	4759	10	4759 Ti
	4765	10	4761 Mn
	4771	10	4765 Mn
	4782	6 *w*	4779 Co 4782 Mn
	4789	4	
	4794	2	4792 Co
13	(4803)	6	
	4804	6	4804 Ti
	4808	10	4809 Zn
	4811	9	
	4824	4	4814 Co 4823 La Di Mn
	4831	4	
	(4834)	2	
14	(4842)	8	4840 Co
	4843	8	
	4849	9 *w*	
	4855	8	4855 Ni 4859 Fe
	4869*	6 *b*	4866 Ni 4871 Fe
	4881	4	4873 Ni 4877 Fe
	(4884)	4	4885 Ti
15	(4892)	3	4891 Fe
	4897†	6 *b*	4899 La Di
	4908	2	4911 Zn
	4917	3	4919 Fe
	4922	2	4920 La Di 4921 La Di
	4934	1	
	4937	1	

w = wide line. *f* = narrow or fine. *b* = band.

* See bright line spectrum (Table I.) † Probably a triplet.

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
16	(4951)*	10	
	4954	10 *b*	4957 Fe
	4963	10 *b*	
	4981	8 *b*	4981 Ti
	(4986)	8	4990 Ti
17	(4998)	9	4999 Ti
	5003	9 *b*	5001 Fe, 5006 Fe
	5018	7 *b*	5007 Ti, 5013 Ti
	5035	5 *b*	5036 Ti
	(5039)	5	
18	(5046)	6	
	5050	6 *b*	5049 Fe
	5062	6 *b*	5064 Ti
	(5066)	6	5068 Fe
19	(5074)	3	
	5077	4 *w*	
	5085	4 *w*	
	(5088)	3	
20	(5098)	4	
	5099	4	
	5107	5 *w*	
	5112	3	5120 Ti
	5124	2 *w*	5129 Ti
21	(5135)	3	
	5139	3 *w*	5139 Fe
	5148	3 *w*	
	(5151)	3	

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
22	(5162)*	10	
	5165	10 *w*	5167 Fe Mg
	5171	10 *w*	5171 Fe
	5185	8 *b*	5172 Mg, 5183 Mg, 5191 Fe
	5201	8 *b*	5193 Ti, 5204 Cr, 5206 Cr
	5212	8 *b*	5208 Cr, 5210 Ti
	5224	4 *w*	5223 Ti, 5226 Fe
	(5227)	4	5232 Fe
23	(5237)	8	5238 Sr
	5244†	8 *b*	
	5265†	8 *b*	5265 Fe, 5268 Fe, 5269 Fe
	5280	7 *b*	5283 Fe Ti, 5297 Ti
	5292	3	5301 Fe, 5327 Fe
24	(5306)	7	
	5310	7 *b*	
	5320	7 *b*	
	5335	4 *b*	5337 Ti
	5344	3	
	(5346)	3	
25	(5356)	6	
	5358	6	
	5364	8 *w*	
	5371	5	5371 Fe
	(5373)	5	

w = wide line.
f = narrow or fine.
b = band.

* See bright line spectrum (Table I.)
† Probably a double.

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
	5385	1	
	5391	1	
26	(5406)	2	5405 Fe
	5409	2 *w*	
	5416	1	5415 Fe
	(5418)	1	5423
	5431	1 *w*	5428 Fe
			5433 Fe
27	(5447)*	10	5446 Fe
	5450	10 *b*	
	5460	10 *b*	5455 Fe
			5460 Hg
	5473	7 *w*	5475, 5477 Uranium
	5479	7 *w*	5480 Sr
			5479 Uranium
	5486	3	5482 Uranium
28	(5498)	5	5494 Uranium
	5499	5	
	5503	9 *w*	
	5514	5 *w*	5512 Ti
			5513 Ti
	5527	3 *w*	5527 Uranium
	5536	3 *w*	
	(5539)	3	
	5548	1	
	5559	2 *w*	5562 Sn
29	(5570)	7	
	5574	7 *b*	5571 Fe
	5587	4 *w*	5586 Fe
			5587 Ca
	(5589)	4	5588 Sn

o Ceti.

Band Nos.	Wave-lengths.	Intensity and Character.	Strong lines of Iron, &c.
30	(5597)	8	5597 Fe
	5603	8 *b*	5602 Fe
			5615 Fe
	5626 †	9 *b*	
	5642	7 *b*	5643 Ti
	(5647)	7	5658 Fe
31	(5660)	7	
	5661	7	5662 Ti
	5667	8 *w*	
	5674	7	5674 Ti
	5689	5 *w*	
	5696	3	
	(5698)	3	
32	(5709)	3	
	5710	3	5708 Fe
	5720	5 *b*	
	5739	4 *b*	
	(5745)	4	
33	(5756)	8	
	5761	8 *b*	5768 Hg
	5771	8 *b*	
			5790 Hg
	5792	3 *b*	
	(5796)	3	5798 Sn
34	(5804)	8	
	5808	8 *b*	
	5821	8 *b*	
	(5827)	8	
35	(5840)	8	
	5845	8 *b*	
	5857	8 *b*	
	(5862)	8	

w = wide line.
f = narrow or fine.
b = band.

* See bright line spectrum (Table I.)
† Probably a double.

After this paper was presented to the Society, a method of reproducing stellar spectra from orthochromatic plates, corrected for the sensibility curve of the plate, was suggested by Mr. W. McKeon, Assistant at this Observatory. It promises well enough to be recommended to other workers in stellar spectrography.

The orthochromatic negative is screened, during the enlarging exposure, by a reversal of the *continuous* spectrum of the negative. The screen is obtained as a glass positive of the orthochromatic continuous spectrum of a coal-gas light filtered through a blue glass during part of the exposure.

Theoretically the perfect screen is the positive of the *star's* continuous spectrum, and of the same density as the stellar negative. It is therefore necessary to have in readiness a large number of screens varying both in the relative intensities of the blue and yellow impressions and in general density. When these are prepared and labelled, it is not difficult to select the suitable screen for producing an enlargement of fairly uniform intensity.

Comparison of the Forthcoming Greenwich Ten-Year Catalogue for 1890, *with certain Fundamental Catalogues.*

(*Communicated by the Astronomer Royal.*)

In the preparation of the Greenwich Ten-Year Catalogue for 1890, the reduction of the fundamental stars has been completed in advance of the rest of the catalogue, as Dr. Auwers wished to be furnished with the results for use in the preparation of his New Fundamental Catalogue. The positions for 1890·0, given by the Greenwich Observations 1887–1896, have been obtained for the fundamental stars in the two catalogues of stars contained in the *Berliner Jahrbuch*, and, as a check on the numerical accuracy of the reductions, a comparison of the Greenwich results has been made with the catalogues of fundamental stars given in the *Berliner Jahrbuch* (Auwers), *American Ephemeris* (Newcomb and Boss), and Professor Newcomb's "New Fundamental Catalogue" adopted in the *Nautical Almanac* for 1901, and at the same time the systematic differences have been obtained. As the Greenwich Catalogue will probably not be completed for a year, it is of interest to give briefly the result of these comparisons.

In the New Greenwich Ten-Year Catalogue the methods of reduction are similar to those of the Ten-Year Catalogue (1880). Although the observations of the Sun showed a correction to the equinox, the changes in the observers made it probable that this was largely caused by differences of personality in observations of the Sun, and it was therefore considered better to apply no correction, but to keep the same equinox as that adopted in the 1880 Catalogue. The adopted colatitude and refractions are the same as in the 1880 Catalogue.